Vision for an Integrated Emergency Response Framework

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Presentation Topics

- *Background and introduction*
- *Integrated Emergency Response Framework (iERF)*
- *Potential iERF contributors*
- *Anticipated Technology*
- *Roadblocks*
- *Conclusions*

Acknowledgment: The screenshots have been adapted from Sim City 4 website.

Background

- *Initial calls from simulation vendors after 9-11*
- *Establishment of the NIST Homeland Security strategic focus area*
- *Prior work on adapting the DoD Defense Modeling and Simulation Office's (DMSO) High Level Architecture (HLA) to distributed manufacturing simulation and commercial manufacturing simulators*
- *Simulation standards would be needed to make more effective use of modeling and simulation in the area of emergency response*
- *Recognition that current specifications activities could be extended to support other simulation domains*

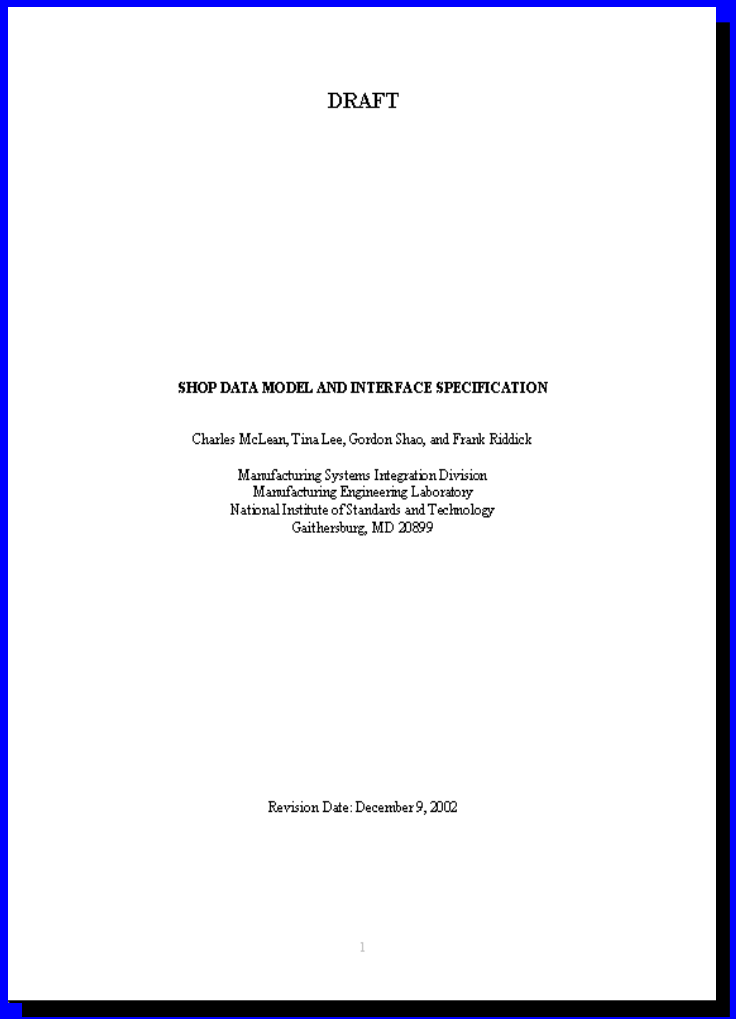
Simulation standards must:

- *Establish interfaces for data import and export between simulation systems, other software applications, and databases*
- *Reduce model development costs through neutral simulation component libraries*
- *Provide common user interfaces and enhanced capabilities, e.g., higher level programming languages*
- *Lead to commercial implementations in off-the-shelf simulation products*
- *Permit customization to meet individual user needs within the emergency response community*

Relevant Past Work at NIST

- *Worked with simulation software vendors and DoD on architectures and mechanisms for efficiently integrating distributed manufacturing simulations.*
- *Experience developing integration architecture, interfaces, software, test beds for integrating simulation, graphics visualization, other applications and databases.*
- *Recognized experts in quality and conformance test development*
- *Using Extensible Markup Language (XML) as an integration mechanism on several projects*
- *Information model for representing data in XML Registries*
- *Distributed simulation using the DoD High Level Architecture (HLA)*
- *Architectural Description Languages (ADLs) to analyze the robustness of distributed systems*
- *Data modeling using the Unified Modeling Language (UML)*

An Example - Shop Data Model and Interface Specification



DRAFT

SHOP DATA MODEL AND INTERFACE SPECIFICATION

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- *150 page specification and growing*
- *Contains Unified Modeling Language (UML), Extensible Markup Language (XML), and text definitions of data*
- *Developed by NIST as part of Software Engineering Institute (SEI) TIDE Program*
- *Being piloted at Kurt J. Lesker Co. semiconductor process equipment fabricator*

Manufacturing Data Types

Organizations
- *Customers & suppliers*
- *Departments*

Product & process specifications
- *parts*
- *bill of materials*
- *process plans: routing & operation sheets, machine programs*

Production operations
- *calendars & shifts*
- *work: orders, jobs, tasks*
- *time sheets*
- *procurements*

Inventory

Layout

Resource definitions
- *stations*
- *machines & setups*
- *cranes*
- *tools & fixtures*
- *employees*

Setup Definitions

Skill Definitions

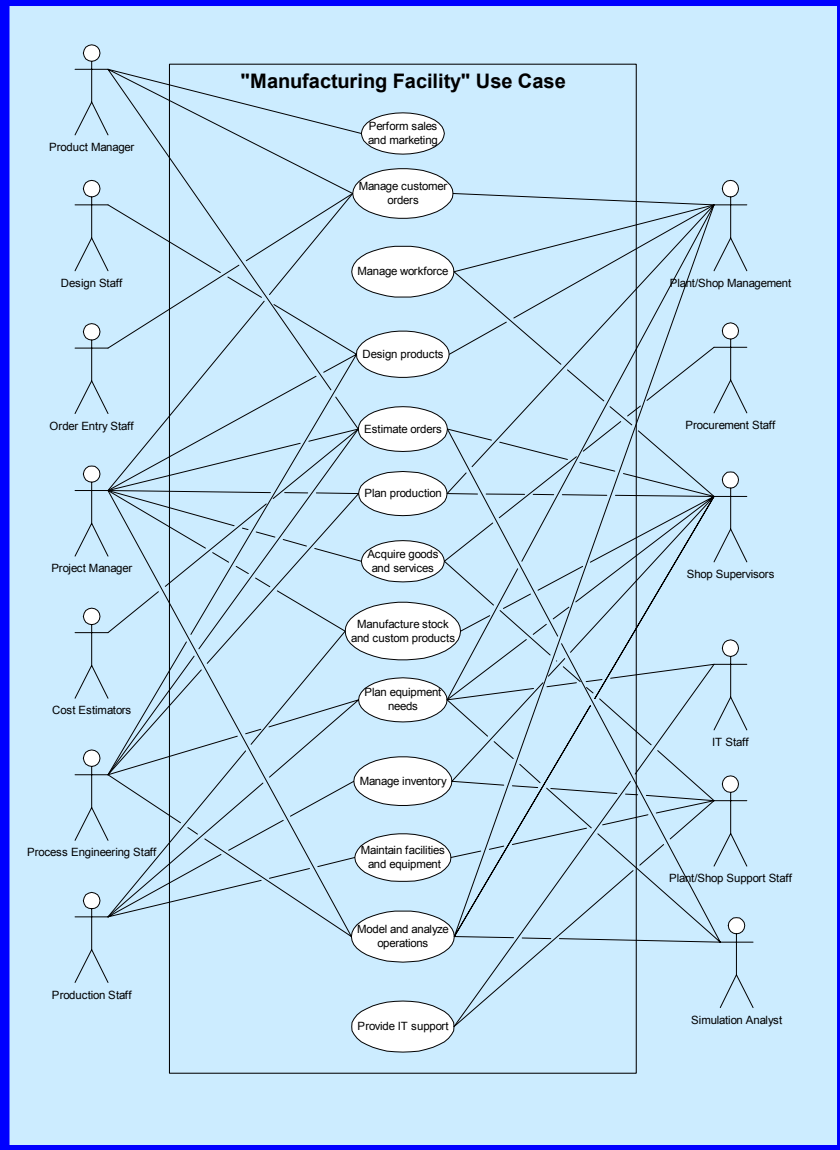
Operation Definitions

Maintenance Definitions

Miscellaneous
- *revisions*
- *references*
- *units of measurement*
- *probability distributions*

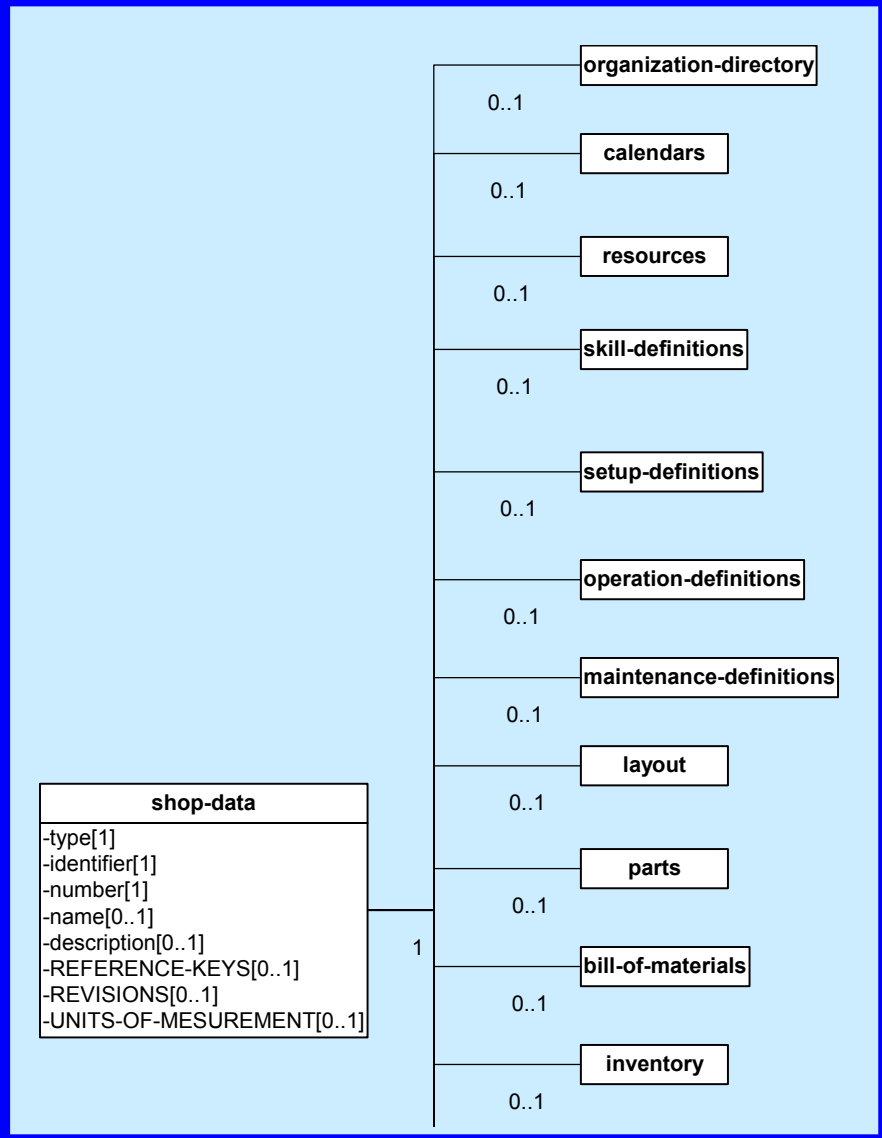
UML Use Cases

- Generic use case diagrams were created to identify the various actors and their roles
- Stick figures represent actors
- Ellipses identify a use case (function or capability)
- Box defines the overall system boundary
- Lines indicate communication links or interactions between actor and use cases
- Lower level use case diagrams decompose higher level use cases



UML Data Models

- Static structure diagrams are used to create a high level conceptual definition for data types needed to support a use case
- Static structure diagrams identify:
  - major data types
  - their attributes
  - enumeration of value constraints for data attributes
  - relationships between major types



XML Code for Data Model

- Extensible Markup Language (XML) is used to define the exchange formats for UML information models
- XML - a standard supported by the World Wide Web Consortium (W3C)
- Supports development of structured, hierarchical data entities that contain a high level of semantic content
- Both human and machine interpretable

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            <resources-assigned />
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        </job-schedule>
    </jobs-section>
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        <task-schedule>
            <task-key />
            <resources-assigned />
        </task-schedule>
    </tasks-section>
```

New Simulation Standards Consortium

- Consortium to address industry, government, and academia's simulation standards needs
  - Educate simulation user and vendor community on standards technology, opportunities, and status
  - Identify and prioritize industry interface standards requirements
  - Harmonize and integrate relevant existing and evolving specifications and standards
  - Ensure vendor commitment to implementation of solutions
  - Develop new draft standards specifications and prototype implementations that demonstrate feasibility
- Work groups are being formed in special interest areas:
  - Facilities layout
  - Management, planning, and scheduling
  - Supply chains
  - Human modeling
  - Distributed simulation
- Kick-off meeting held at NIST on 25 February 2003

Consortium Participants

Government
- Defense Modeling Simulation Office
- NIST (Coordinator)
- Navy Air Warfare Center
- Navy Modeling and Simulation Management Office
- Navy Facilities Engineering Service Center
- Tinker Air Force Base

Software Vendors
- Brooks Automation - Autosimulation
- Delmia (Deneb Robotics)
- EDS
- Knowledge Based Systems Inc. (KBSI)
- Lanner Group
- Manugistics
- MicroAnalysis and Design
- ProModel Corporation
- ProPlanner
- Rockwell Software - Systems Modeling Corporation
- Simul8
- Softimage
- Wolverine Software

Industry
- Altarum
- Boeing Company
- Ford Motor Company
- Forging Industry Association
- General Motor
- John Deere

Research Institute
- Software Engineering Institute

Academia
- Arizona State University
- Florida International University
- Virginia Polytechnic Institute
- Oklahoma State University
- University of Cincinnati

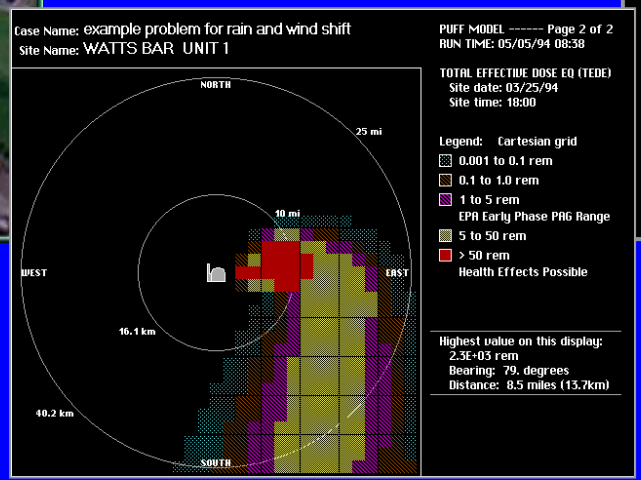
Our Emergency Response Objectives

- *Organize a workshop to identify ongoing efforts and response community needs*
- *Document needs, data requirements, collaboration and standards opportunities, and a roadmap for achieving common objectives*
- *Develop a vision for an integrated Emergency Response Framework (iERF)*
- *Define interoperability and standards requirements for implementing integrated simulation environments*
- *Work with partners on the development of interface specifications, prototypes, and testing capabilities to achieve our common vision*

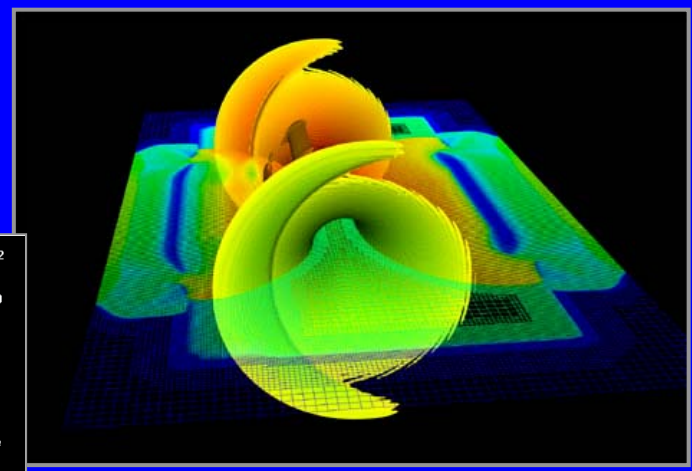
Introduction

- *Simulation can play an important role in emergency response and preparedness.*
- *A number of efforts for using simulation to study different kind of disasters are in progress.*

Chemical Plant Fire Simulation – Star Technology Corporation



Radiological Accident Modeling for Emergency Response - ORNL



Nuclear Weapon Simulation - LANL

Motivation

- *Integration of the individual efforts will enable looking at the whole picture*
- *Interoperability of these efforts can synergistically increase the effectiveness tremendously*

Simulation of Emergency Response

Scenario – Explosion at a public building resulting in a major fire and casualties

Explosion Simulation

Building Fire Simulation

Information flow modeling

Emergency vehicles response simulation

Traffic flow simulation

Hospital system simulation

City Map with Street details, Police, Fire, Hospital Locations

Availability of response personnel

Population density information by time of day

Federal, State, Local authority network spec.

Acknowledgment: The building fire screenshot has been adapted from Sim City 4 website.

Emergency Response Modeling and Simulation Requirements

- *Reduce time for model development for emergency response*
- *Reduce model development costs through neutral simulation component libraries*
- *Permit customization to meet individual scenario needs*
- *Standardize interfaces for data import and export between simulation systems, other software applications, and databases*
- *Provide common user interfaces and enhanced capabilities, e.g., higher level programming languages*
- *Provide rapid communication of results to users*

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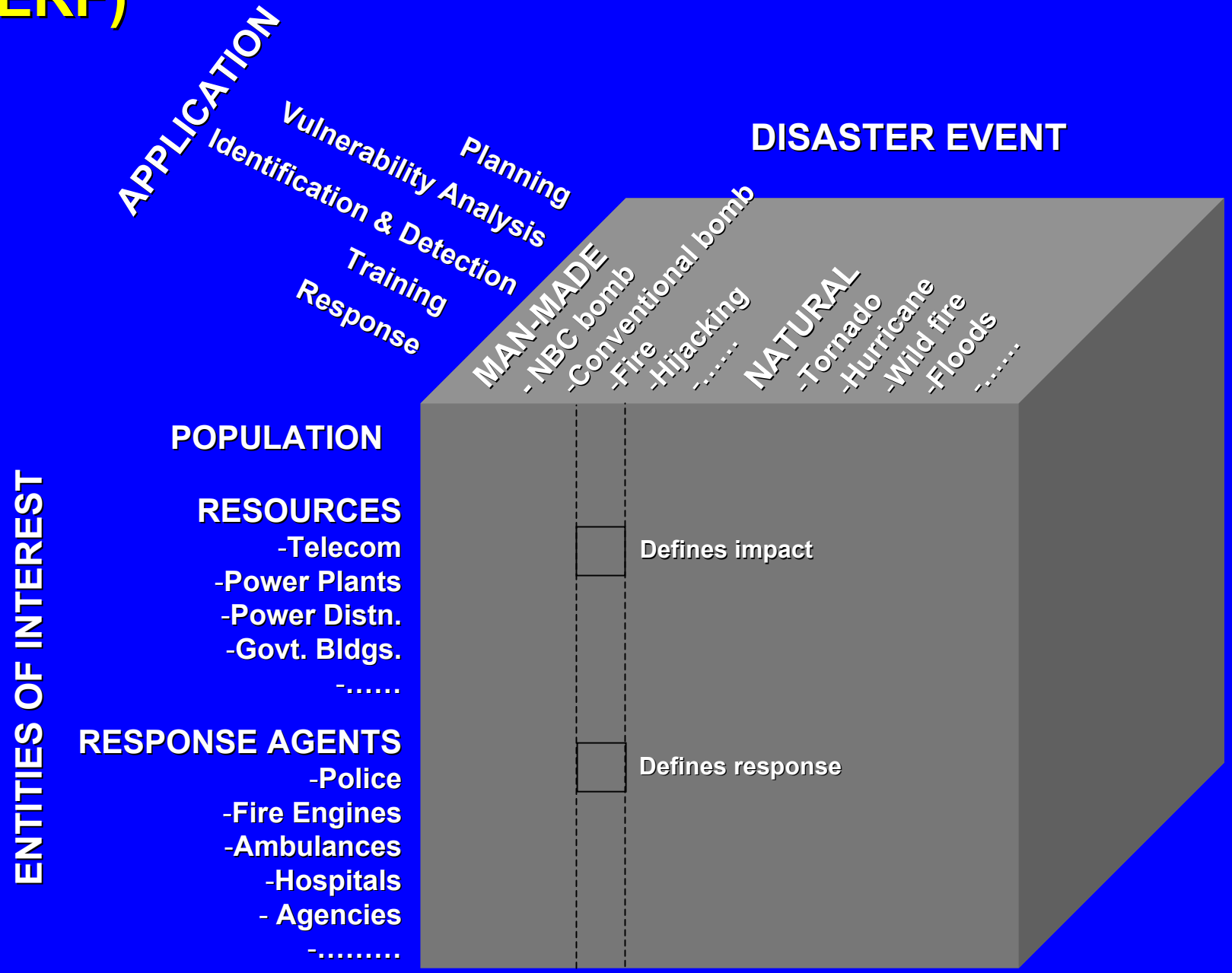
Integrated Emergency Response Framework (iERF)



iERF – Example 1

Application:
Response

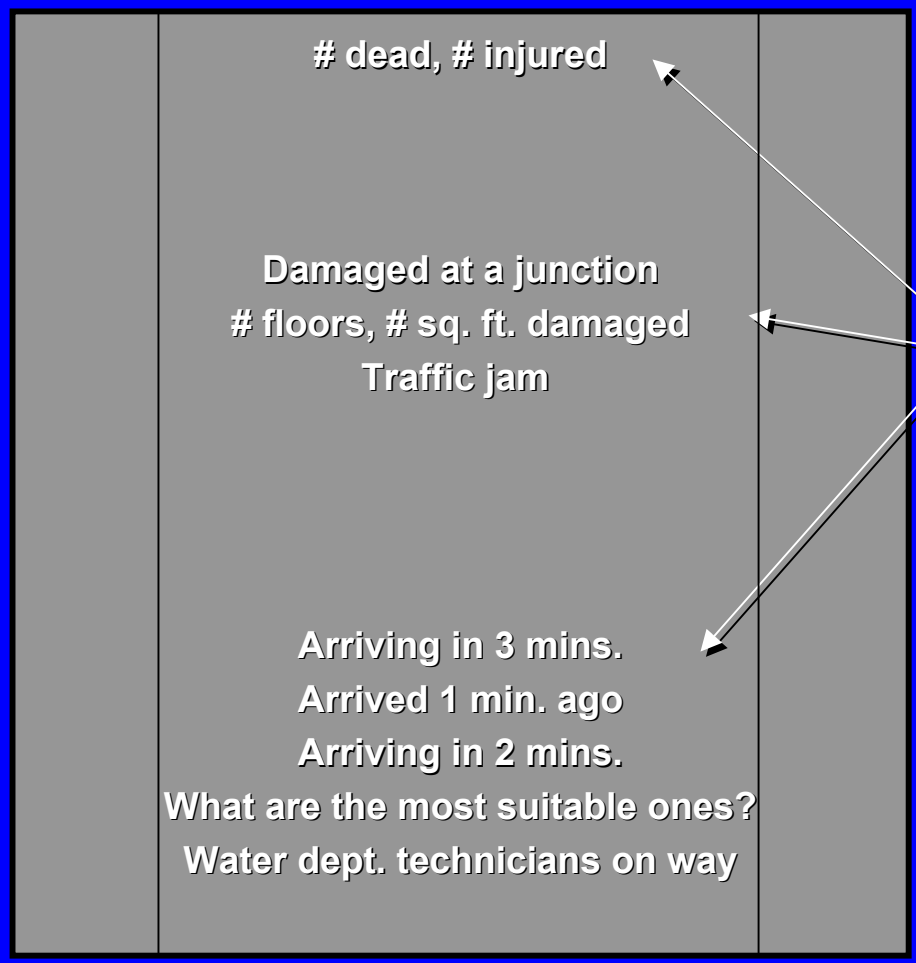
Disaster Event -
conventional bomb at a public place

Entities of Interest

Population

Resources
- -Water line
- -Public Bldgs.
- -Road Network

Response Agents
- -Police
- -Fire Engines
- -Ambulances
- -Hospitals
- - Utility Repair
- -……

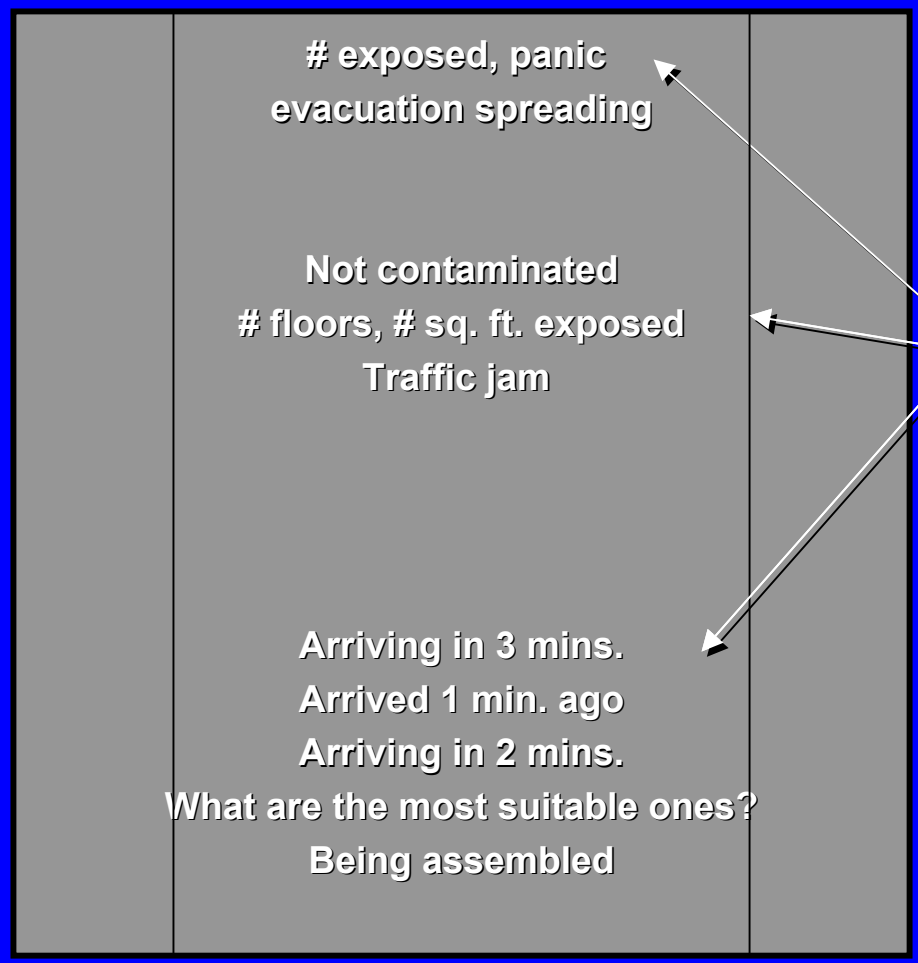


Modeling, simulation & visualization capabilities can be used to understand current and future impact and plan response

iERF – Example 2

Application:
Response

Disaster Event – Anthrax dispersion at public place



Modeling, simulation & visualization capabilities can be used to understand current and future impact and plan response

Application Examples

- *Planning*
  - *Location of police and fire stations and hospitals*
  - *Development of evacuation procedures*
  - *Setting up of communication infrastructure*
- *Vulnerability Analysis*
  - *Evaluation of security plans and procedures*
- *Identification & Detection*
  - *Selecting security sweep targets*
- *Training*
  - *Antidote deployment sequence*
  - *Evacuation management*
- *Response*
  - *Antidote deployment sequence*
  - *Evacuation management*

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Sample Data and Sources

TYPE OF DATA	POTENTIAL DATA SOURCES
Terrain maps	*US Geological Survey*
Street maps	*City office* *Map software companies* *Atlas publishers*
Response agency locations *Response plans*	*City office , police, fire and health departments*
Utility and infrastructure locations	*Utility companies, telecom companies*
Weather	*National Oceanic and Atmospheric Administration*
Population density	*US Census Bureau*
Business area population density, *Transportation patterns*	*Local transportation departments*
City evacuation plans	*City office*
Building design records	*City office, building management*
Building evacuation plans	*Building security*
……	……

Sample Domain Knowledge Sources

DOMAIN AREA	POTENTIAL SOURCES
Nuclear agent impact	*Defense agencies, DOE National Labs*
Bio-agent impact	*Center for Disease Control (CDC)*
Chemical agent impact	*Defense Agencies*
Spread of NBC agents	*National Atmospheric Release Advisory Center (NARAC), DOE National Labs, Defense agencies*
Conventional bomb explosion impact	*Defense consultants, Defense agencies? Universities?*
Fire modeling	*Building & Fire Research Lab – NIST, Universities?*
Traffic flow modeling *Emergency response vehicle flow*	*Transportation research center at Universities, Transportation departments*
Hospital modeling	*Consulting companies, Universities*
Attack response training	*Institute for Defense Analysis and SAIC*
Human behavioral model	*Universities*
……	……

Sample Tools and Sources

TYPE OF TOOLS	POTENTIAL SOURCES
Discrete event simulation software	*Software vendors (Brooks PRI Automation, Delmia, Promodel Corp, Rockwell Automation, Tecnomatix, etc.) DOE National Labs*
Continuous simulation software	*Software vendors, DOE National Labs*
Databases	*Software vendors*
Integration software	*Software vendors*
Visualization software	*Software vendors*
Emulation software	*Software vendors (Brooks PRI Automation, etc.)*
.....	.....

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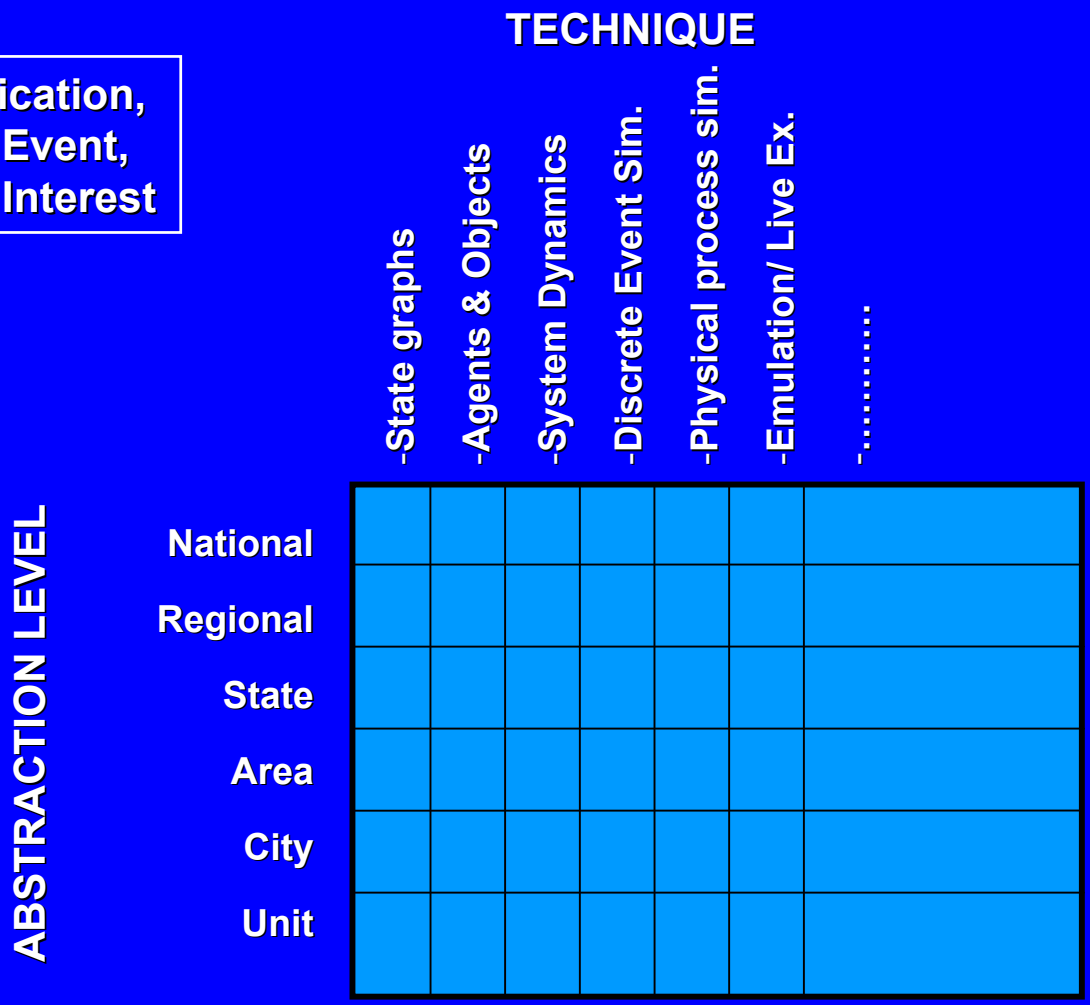
iERF – Modeling & Simulation Tools

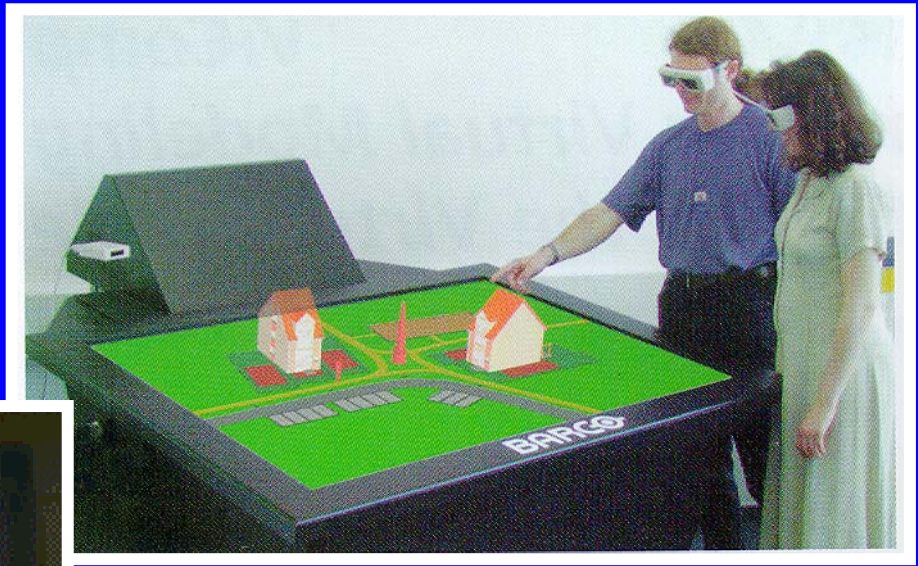
Modeling & Simulation Tools are needed for each cubic cell of the previous iERF framework and they can be classified further based on the following. Several are already developed or under development.

For X Application,
Y Disaster Event,
Z Entity of Interest



iERF – Visualization Tools

- *Graphs*
- *Flow Diagrams*
- *2D displays*
- *3D displays*
- *Immersive Virtual Reality*



Applicability of Distributed Simulation

- *Providing capabilities that do not exist in a single simulator*
- *Modeling of problems that run across multiple agencies where some information from each agency may be hidden from others*
- *Modeling multiple domains of terrorist response (bomb blasts, chemical, biological, nuclear cloud dispersion)*
- *Creation of hierarchical models that reflect different levels of aggregation of the modeling domain*
- *Hiding proprietary information about the internal workings of a simulation*
- *Creating low-cost run-time simulation models*
- *Taking advantage of computing power afforded by distributing execution*
- *Providing simultaneous access to models for users in different locations*
- *Providing different numbers and types of licenses for different simulation activities (model building, visualization, execution, analysis).*

Distributed Simulation Environment for Emergency Response

Possible Emergency Response Organizations

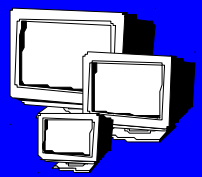
- Police - FBI
- FEMA
- Hospitals
- Local Utilities
- Fire and Rescue
- Local Govt
- Defense National Guard
- CDC Health
- Volunteer Orgs
- . . .

Simulation Modes and Functions

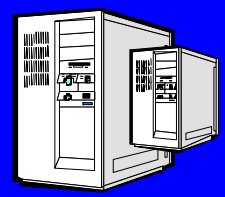
- Planning
- Vulnerability Analysis
- Identification & detection
- Training
- Real-Time Response Support

Distributed Simulation System

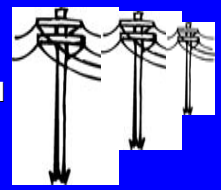
Remote interfaces & visual systems



Distributed simulation engines, models & databases



Networked data sources



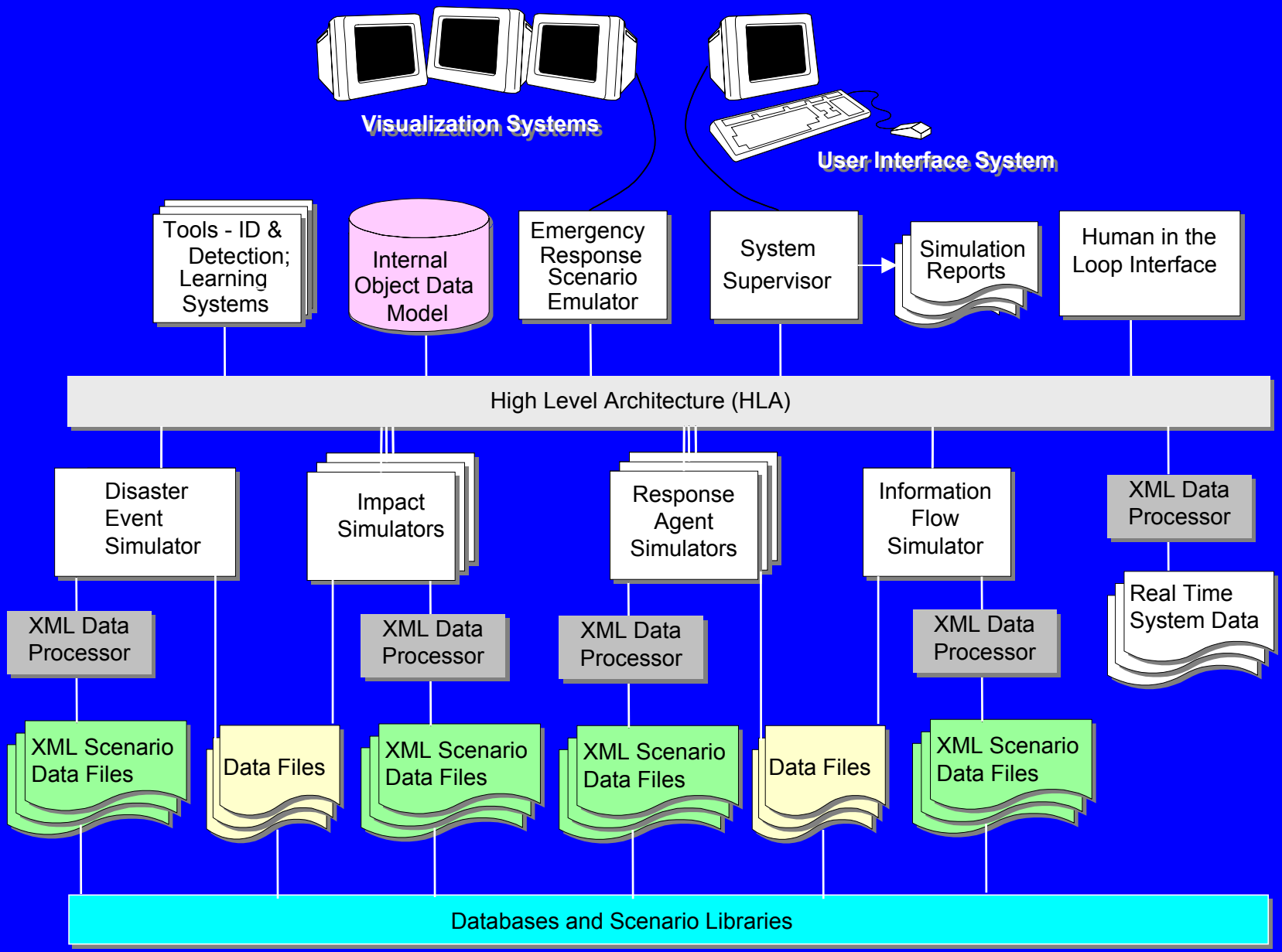
Response Domains

- Fire & Rescue
- Medical Treatment
- Bomb Disposal
- Traffic & Transportation
- Security
- Utilities Emergency Repair
- NBC Response & Cleanup
- Media
- . . .

Key technical elements

- *Distributed simulation environments*
  - *Standards for interconnection of different simulation models into distributed environments*
  - *Mechanisms to coordinate the initiation, execution and shutdown of distributed simulations, enable data transfers from dispersed data sources, and provide time synchronization.*
- *Simulation transactions*
  - *transfer information and simulated objects among distributed simulations while they are executing.*
- *Simulation templates and model formats to significantly reduce simulation development costs for users.*
- *Reference data sets for developers to test their software and perform integration tests with real world data.*

Proposed Architecture



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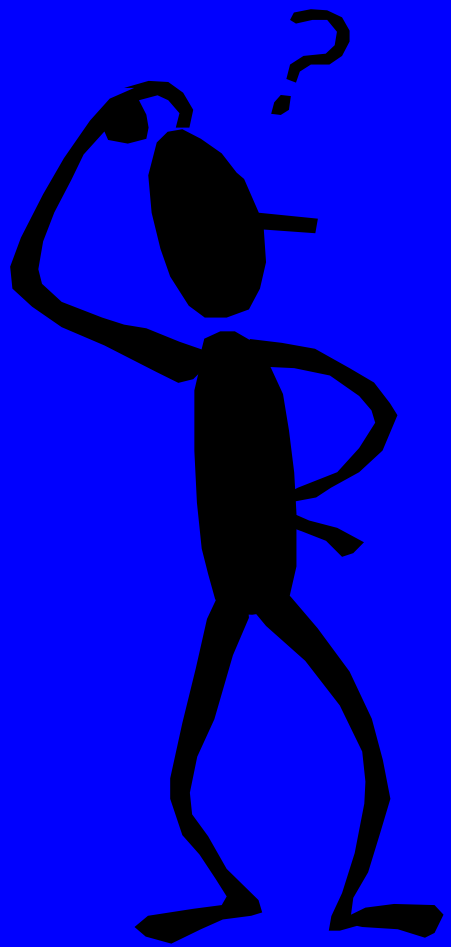
Roadblocks to vision

- *Data issues*
  - *Required data is not identified and not available*
  - *Available data is not in standard formats*
- *Integration issues*
  - *Available tools have been independently developed with proprietary interfaces*
  - *May not be designed for operating securely in an open environment*
- *Roadmap*
  - *No common process for development, validation and certification of tools*
  - *No defined process and responsibilities for standards development*
- *User requirements*
  - *No standard mechanism for making the capability available to response community - organizational and infrastructural*
  - *Diverse skill levels of potential users*

Conclusions

- *Critical need exists for rapid development of modeling, simulation and visualization capabilities for emergency response.*
- *Rapid development can be achieved by bringing together multiple ongoing efforts in an integrated framework.*
- *Interoperability standards are key enablers for the integrated framework.*
- *Modeling and Simulation for Emergency Response community needs to work together to develop a vision and address the roadblocks to vision*



Questions and discussion?